Regional San South Sacramento County Agriculture & Habitat Lands Recycled Water, Groundwater Storage, and Conjunctive Use Program

Preliminary Operations Plan

Contents

Preliminary Operations Plan

1. Program Overview

This document describes the operations for the proposed South Sacramento County Agriculture and Habitat Lands Recycled Water, Groundwater Storage, and Conjunctive Use Program (South County Ag Program or Program). This recycled water, groundwater storage and conjunctive use program is designed to strike a balance between water resources sustainability, ecosystem enhancement, and agricultural sustainability in an increasingly urban environment, supporting Regional San’s commitment to environmental stewardship for the Sacramento Region.

2. Program Operations and Benefits

2.0 Recycled Water Delivery Operations

The average annual recycled water delivered to participating irrigation customers at full program implementation would be up to 49,500 AFY, including 5,000 AFY to a potential direct winter irrigation recharge (wintertime recharge) area, and an additional 500 AFY delivered directly to Stone Lakes National Wildlife Refuge (NWR). Recycled water would be delivered year-round to approximately 16,000 acres of irrigated farmlands for in-lieu use during the irrigation season and wintertime recharge for non-irrigation season, with up to 560 acres of direct recharge within that footprint, as well as supporting 400 acres of managed wetlands at Stone Lakes NWR during the spring and fall. The Program would be designed to provide two-thirds of the maximum month demand, 32,500 AFY on average and up to 37,000 AFY, augmented with existing private wells currently used for irrigation supply to provide peak water delivery, at approximately 9,200 AFY. Thus, during peak irrigation demands, exceeding two-thirds of maximum month demand, would be supplied by customers’ existing wells.

Table 2-1 shows the estimated recycled water deliveries for the Program. Figure 2-1 shows an expected distribution of total irrigation water demand and proportion of demands met by recycled water and groundwater pumped by existing groundwater wells over the course of a normal water year.

Table 2-1. Recycled Water Deliveries under the Action Alternatives

Alternative	Wetlands		Crop Irrigation (Growing Season/ Non-growing Season			Recharge		
	Area (Acres)	Recycled Water Usage (AFY)	Irrigated Area (Acres)	Recycled Water Usage (AFY)	Ground-water (customer wells) (AFY)	Area (Acres)	Recycled Water Usage (AFY)	Total Delivered Recycled Water (AFY)
Proposed Program Irrigating Season	400	500	16,000	32,500 (average)	9,200	560	0 (included under crop irrigation)	32,500 on average (up to 37,000)
Proposed Program with Winter Recharge	400	500	16,000	44,500	9,200	560	5,000	50,000

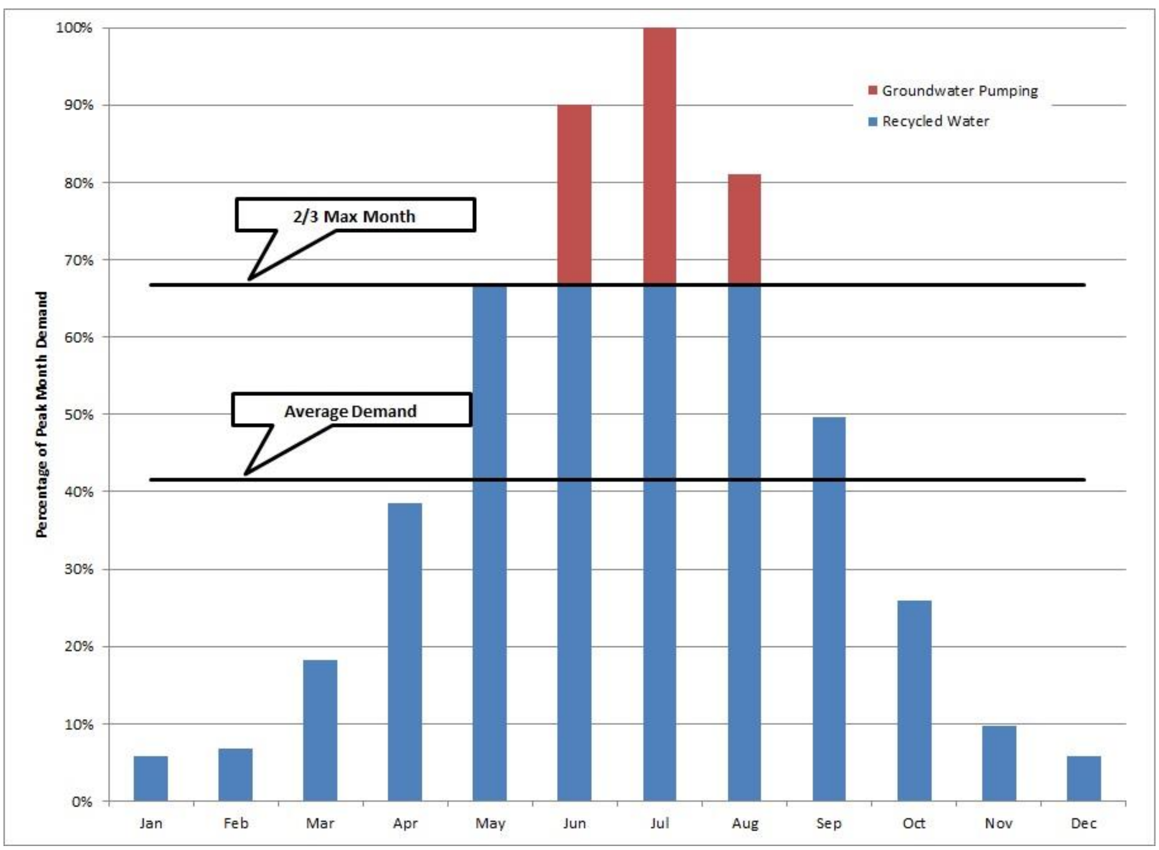

Figure 2-1. Monthly Demand for Water

Recycled water deliveries would be differentiated by two different parts of the year: Irrigation Season and Wintertime. The Irrigation Season runs from May to September and Wintertime runs from October to April. During the Irrigation Season, an average of 32,500 AFY (up to about 37,000 AFY) of recycled water would be delivered for agricultural irrigation, providing a commensurate amount of in-lieu recharge to the groundwater basin. In Wintertime months, additional recycled water would be delivered to irrigation areas and wildlife-friendly recharge areas for recharge. Wintertime recharge deliveries would bring annual recycled water deliveries up to 49,500 AF. The remaining 500 AFY would be delivered, as needed, during the spring and fall to Stone Lakes National Wildlife Refuge.

The provision of recycled water to irrigation customers and for recharge would result in a reduction in the discharge to Sacramento River. Thus, Regional San would reduce discharge by up to 50,000 AFY at full program implementation, with agricultural irrigation in the growing season plus other program elements including wintertime irrigation. However, use of recycled water would benefit the groundwater basin, and higher groundwater levels would result in increased flows in the Cosumnes and Sacramento River because less water would flow out of those rivers into the groundwater basin. Once the groundwater basin reaches equilibrium, in approximately 20-30 years, the Program is expected to increase streamflows by about 45,000 AFY with implementation of wintertime irrigation. In the initial phase when irrigation is only occurring during the growing season, discharge to the Sacramento River would be reduced by about 32,500 AFY. However, the Program is ultimately projected to increase streamflows by over 28,000 AFY, thus reducing potential impacts.

2.0.1 Public Benefits

Operations of the Program will support the following public benefits:

- Ecosystem Improvements
- Water Quality Improvement
- Emergency Response[1]
- Recreation

The ecosystem benefits will be achieved as a result of the water application and delivery, active management to achieve the ecosystem benefit, habitat restoration requiring active management or implementation, and complimentary changes in land management to support wildlife. Water quality improvements will occur by removing a salt load from the Sacramento River. Emergency response can be improved by the delivery pipeline being constructed with standpipes that meet the specifications for emergency fire response that can be utilized by rural fire departments. Recreation opportunities include bird watching and hiking at the Cosumnes River Preserve and Stones Lake National Wildlife Refuge, and canoeing on the Cosumnes River.

The ecosystem benefits are extensive, and do not vary much by water year type. An Ecological Plan was developed to document the benefits for monetization, and the following sections are

[1] Emergency response benefits are still in development and feasibility analysis. These benefits are not being quantified or monetized at this time.

excerpts from the Ecological Plan that support the ecosystem benefit claims and lay out operational criteria, monitoring, and adaptive management for achieving those benefits. Water quality and recreation benefit values are not anticipated to change substantially under varying hydrologic conditions because recycled water supplies would be more resilient to hydrologic changes and the perceived values of those benefits should increase with increasing scarcity of other water supplies.

Ecological Plan Approach and Goals

The ecological plan's approach is, in its most simple form, the improvement of the water table such that the gradient flows back to the streams, instead of away from them, as currently happens due to significant groundwater overdraft. The increased stream flow increases migrating (anadromous) fish passage days in the Cosumnes River, improves year-round native (resident) fish habitat conditions through cool groundwater flows toward the river (upwelling), improves riparian vegetation regeneration due to the raising of the water table (reduced rates and reversal of hydrograph decline), supports much larger areas of riparian vegetation with near-surface water tables, and provides drought persistence for mature riparian vegetation with shallow groundwater maintenance.

These shallow groundwater improvements have significant ecological effects through the reversal of the cone of depression in the northern part of the program area. The groundwater elevations are such that the cone of depression reverses the natural gradient to the Cosumnes River and Snodgrass Slough complex, causing those water bodies lose water to the gradient and act as "losing streams" for most water years without the project. The Program results in a reversal of that cone of depression and rapidly equilibrates the groundwater system, allowing these rivers become "gaining," in just over a decade.

There are two key take-aways of the ecological analysis to date. The first is that program modeling assumes that the in-lieu and winter recharge happens evenly across the program area. This assumption is a conservative approximation so that reviewers can see the Program benefits that would accrue under any program execution scenario. However, the purpose of this ecological component of the Preliminary Operations Plan is also to identify the strategic implications of the water recharge in areas targeted for ecological benefits. Recharging preferentially to the east and south, closer to the Cosumnes, can significantly improve the recharge flow benefits and maximize the area of the River that has benefits in the 2070 climate change scenario, in effect reversing the modeled impacts of climate change for this area.

The second take-away is that without this Program, the Stone Lake National Wildlife Refuge, the complex of private conservation lands, and the Cosumnes Preserve, all would be disconnected from the water table under all water year classes by 2070. Resulting in significant losses of habitat function in those areas that cannot be supplemented with surface water.

These Program groundwater benefits can be enhanced by changes in land management practices that improve habitat. By implementing a strategic groundwater supplementation program through winter recharge, terrestrial and wetland species that are seasonally present in the agricultural areas will have substantially more habitat available during the critical overwintering period, and local benefits to stream recharge through groundwater are directed to where they are needed the most.

The hydrogeographic benefits of the program will, by themselves, create the conditions that support native riparian vegetation. However, supporting acres of wetland habitat and linear feet of riparian habitat, as critical as those actions are, can be significantly enhanced through invasive weed management, widening the riparian corridor belt width, and reconnecting areas that have been modified to create a longitudinal connection along the corridor. The strategic acquisition of contracts and easements, both long- and short-term, allow for winter recharge, wildlife-friendly crops and cropping practices, riparian management areas, access for weed management, and flexibility to adapt management practices that address climate change. These goals can be supported by adaptive management of the water application that would allow for spreading of the winter water potentially beyond the currently delineated delivery area to maximize the ecological benefits of recharging the aquifer.

These goals can be supported by adaptive management of the water application that would allow for spreading of the winter water potentially beyond the currently delineated delivery area to maximize benefits (described further in the next section).

Ecosystem Benefits

There are four primary ecosystem benefits expected from the program: (1) direct improvement as a result of the water application and delivery, (2) direct improvements that require active management to achieve the ecosystem benefit (e.g.,weed treatment), (3) habitat restoration that requires active management or implementation, and (4) complimentary changes in land management to support wildlife. The following sections describe the ecosystem benefits that are expected as a result of the program. The expected benefits have been quantified using the groundwater modeling results (RMC, 2017), as well as available literature and spatial data. Assumptions or data sources used to complete the ecosystem quantification are included in the description. Additionally, anticipated time-lags associated with the program benefits are documented and quantified.

The focus of the ecosystem benefit assessment has been on identifying the change in physical conditions from the program that will support native species. There are many endangered, sensitive, and threatened species in the program area. The ecosystem benefits of the program will directly improve habitat for many of these species, including:

- California tiger salamander, *Ambystoma californiense*
- Chinook salmon, *Oncorhynchus tschawytscha*
- Giant garter snake, *Thamnophis gigas*
- Greater sandhill crane, *Grus canadenis tabida*
- Riparian brush rabbit, *Sylvilagus bachmani riparius*
- Sacramento splittail, *Pogonichthys macrolepidotus*
- Swainson's hawk, *Buteo swainsoni*

- Tricolored blackbird, *Agelaius tricolor*
- Valley elderberry longhorn beetle, *Desmocerus californicus dimorphus*
- Vernal pool fairy shrimp, *Branchinecta lynchi*
- Vernal pool tadpole shrimp, *Lepidurus packardi*
- Western pond turtle, *Clemmys marmorata*
- White-tailed kite, *Elanus leucurus*
- Willow flycatcher, *Empidonax traillii*
- Yellow warbler, *Setophaga petechia*

Habitat Benefits from Improved Shallow Groundwater Conditions

Numerous studies of the program area have documented the potential ecosystem benefits associated with a reduction in groundwater extraction (Eisenstein & Mozingo, 2013; Fleckenstein et al., 2004, 2001; Kleinschmidt Associates, 2008). As a result of the Program, groundwater extraction in the delivery area will be substantially reduced, resulting in improved groundwater conditions. These improved conditions will result in groundwater elevations that are substantially closer to the ground surface under all hydrologic conditions. These changes in groundwater will result in improved conditions for groundwater dependent ecosystems, including riparian areas and wetlands. Expected improvements to riparian areas and wetlands are summarized in Table 2-2 at the end of the Public Benefits Section. The groundwater improvements will support these ecosystems by providing the necessary conditions to recruit and sustain hydrophilic vegetation.

Within the managed areas that will benefit from the program, four wetland condition surveys using California's Rapid Assessment Method (CRAM; California Wetlands Monitoring Workgroup, 2013) were available. The index scores for these four sites range from 65 to 91 (maximum potential score of 100; Table 2-2), suggesting that the current overall conditions in these managed areas is currently relatively high. As such, the potential improvement in conditions of these habitat is relatively low. On average, the maximum potential increase in condition is 17 points.

Table 2-2. California's Rapid Assessment Method (CRAM) results for four survey sites within the program benefit area. CRAM scores reflect wetland condition and stressors affecting the wetland function. Data from EcoAtlas (CWMW, 2017).

Survey Sites	*Survey Year*	*Index Score (Maximum Score: 100)*
Cosumnes Pond 11	*2014*	*65*
Cosumnes River Preserve depression	*2012*	*87*
Tall Forest	*2005*	*91*
Wendell's Levee	*2005*	*89*

No quantitative habitat quality data were available for riparian or wetland areas on lands not actively managed for conservation purposes. It is likely, however, that these area experience additional stressors and do not exhibit the same level of function as the managed lands. As such, there likely exists a greater potential for improvement on the unmanaged habitats. This potential for improvement would be reflected in lower CRAM scores. Pre- and post-Program CRAM assessments will be completed, and these and other quantitative monitoring approaches will be used to track the success of the Program and adapt the management as needed to improve CRAM scores. Given that the existing conditions of the unmanaged riparian and wetland areas are expected to be lower than the managed lands, the changes in shallow groundwater will likely result in greater functional improvements.

Riparian Management and Stream Restoration to Improve Conditions
The shallow groundwater benefits described in the previous section highlight the broad-scale ecosystem improvements associated with the program. While the increase in shallow groundwater levels alone will help to support riparian and wetland habitats, some of the unmanaged areas are severely degraded. As such, it is unlikely that the shallow groundwater improvements will be sufficient to improve conditions on the unmanaged acres. In these areas, the abundance of invasive weeds, such as perennial pepperweed (*Lepidium latifolium*), has resulted in large monocultures that exclude native species (Andrew & Ustin, 2006). To maximum the ecosystem improvement, weed treatment and active restoration is needed on these unmanaged acres.

Active revegetation efforts can include noxious weed treatment followed by the planting of trees and shrubs. While typically effective, active planting can be costly and recent restoration efforts in the area have documented the effectiveness of passive restoration techniques (Robertson-Bryan, 2006). These recent efforts have documented the successful natural recruitment of woody riparian vegetation by restoring hydrologic connectivity to floodplain areas (Robertson-Bryan, 2006; Swenson et al., 2003). Restoring floodplain connectivity facilitates the natural colonization of riparian areas, reducing the cost of restoration.

The existing canopy conditions indicate that very few riparian and wetland areas support a forest canopy.[2] For example, with the program in place, only 17 of the 237 acres of unmanaged forested wetlands are expected to have a canopy with trees 25 feet or taller (Table 2-3). That is, with the program in place under the 2030 climate change scenario, only 7% of the 237 acres that are capable of supporting the establishment[3] of woody vegetation currently have a forest canopy. Substantial restoration potential exists on these acres.

[2] Canopy conditions were characterized from the available 2013 Light Detection and Ranging (LiDAR) data for the program area. The canopy model was developed by calculating the difference between the first-return heights and the bare earth elevations.
[3] Where shallow groundwater levels are within 5 feet of the ground surface more than 80% of the time.

Table 2-3. Number of acres designated as forested wetlands in the National Wetland Inventory where the shallow groundwater is within 5 feet of the ground surface more than 80% of the time. Acreages are divided into two categories based on LiDAR canopy height. Results are presented for the two climate change scenarios.

Forested Wetland Acres with Shallow Groundwater within 5 feet >80% of the Time				
	2030 Climate Change Scenario		*2070 Climate Change Scenario*	
	Baseline	***With Program***	***Baseline***	***With Program***
Managed Forested Wetlands				
Canopy < 25 feet	*10*	*188*	*5*	*25*
Canopy ≥ 25 feet	*1*	*41*	*1*	*2*
Managed Subtotal	***11***	***228***	***6***	***28***
Unmanaged Forested Wetlands				
Canopy < 25 feet	*39*	*221*	*3*	*56*
Canopy ≥ 25 feet	*6*	*17*	*0*	*7*
Unmanaged Subtotal	***44***	***237***	***3***	***63***
Total	***55***	***466***	***9***	***91***

The 2070 climate change scenario results highlight that even with the program in place, the number of riparian and wetland areas with groundwater conditions capable of supporting the establishment of woody vegetation is substantially smaller (Table 2-3). The conditions necessary to support mature[4] hydrophilic vegetation, however, are present under the 2070 climate change scenario with the program in place (Table 2-4). As such, the 2070 climate change conditions do not preclude the reforestation of riparian and wetland areas. Rather, the results underscore the benefit of implementing restoration work earlier in the program so that plants can become established when conditions are more favorable. Once established, vegetation is better able to tolerate the lower groundwater levels, thus substantially increasing the resiliency of the ecosystem.

Additionally, the 2070 shallow groundwater conditions do not prevent the success of revegetation efforts. Rather, under these conditions practitioners would need to utilize different implementation approaches, such as the usage of irrigation, to support initial plant establishment. With the program in place, any established vegetation will have the shallow groundwater conditions necessary to support a mature forest under both climate change scenarios.

[4] Where shallow groundwater levels are within 10 feet of the ground surface more than 80% of the time.

Table 2-4. Number of acres designated as forested wetlands in the National Wetland Inventory where the shallow groundwater is within 10 feet of the ground surface more than 80% of the time. Acreages are divided into two categories based on LiDAR canopy height. Results are presented for the two climate change scenarios.

Forested Wetland Acres with Shallow Groundwater within 10 feet >80% of the Time				
	2030 Climate Change Scenario		*2070 Climate Change Scenario*	
	Baseline	*With Program*	*Baseline*	*With Program*
Managed Forested Wetlands				
Canopy < 25 feet	172	459	59	384
Canopy ≥ 25 feet	60	90	9	77
Managed Subtotal	**232**	**549**	**69**	**461**
Unmanaged Forested Wetlands				
Canopy < 25 feet	256	527	153	451
Canopy ≥ 25 feet	29	47	20	42
Unmanaged Subtotal	**284**	**574**	**173**	**492**
Total	**517**	**1,123**	**242**	**953**

While implementing active restoration or weed treatment on all of these unmanaged acres is beyond the scope of this Program, targeted projects and treatment on a subset of acres is a part of the Program proposal. As part of the South Sacramento County Agriculture and Habitat Lands Recycled Water Program, 100 acres of riparian and wetlands habitat will be targeted for restoration to improve canopy conditions.

Detailed restoration and management plans require site-specific information. These site-specific restoration and stewardship plans will be developed as sites are identified throughout the implementation of the program. These plans will include long-term stewardship objectives and monitoring to ensure that the future ecological conditions and functions are achieved at each individual program. Given the high level of observed ecological function at many of the actively managed sites in the area it is expected that the restoration and stewardship of the targeted 100 acres will also result in high levels of function. Additionally, these areas will also have the supportive shallow groundwater conditions necessary for mature woody vegetation. For the purposes of quantifying the expected improvement in ecological function, it is assumed that these restored acres will achieve a level of function equivalent to a CRAM score of 95.

Changes in Land Management to Support Wildlife

The presence of agriculture in the program area does not preclude the potential to support wildlife. An important aspect of the program will be the collaboration with agricultural producers to receive recycled effluent for irrigation. Working directly with producers will allow for a unique opportunity to engage producers in changes in land management to support wildlife. This complementary aspect of the program will include a combination of targeted applications of water during the winter to flood agricultural fields with changes in crop residue management. Combined, these actions will increase the acreage of available habitat for greater sandhill cranes *(Grus canadenis tabida)* within the delivery area.

The Sacramento-San Joaquin River Delta region (Delta) provides essential winter habitat for California Central Valley greater sandhill crane population (Ivey et al., 2014). Approximately half of all sandhill cranes counted as part of a recent Pacific Flyway survey were observed in the Delta, highlighting its importance as an area for conservation to support the recovery of California sandhill cranes (Ivey et al., 2014).

During the winter, greater sandhill cranes migrate and over-winter in agricultural regions that are dominated by cereal and grain crops, including the Delta (Littlefield & Ivey, 2000). Combined with nearby wetlands for roosting and loafing, the landscape in and around the delivery area is well suited to support greater sandhill cranes (Kleinschmidt Associates, 2008). Additionally, wintering habitat represents an important aspect of the annual life history of greater sandhill cranes as the migrating population is present within the Program area from September through March (Littlefield & Ivey, 2000).

Essential aspects of greater sandhill crane habitat includes grain crops as a source of carbohydrates, and grasslands, pastures, or alfalfa fields for obtaining protein and other nutrients (Golet, 2011). Greater sandhill cranes utilize these habitats for foraging and nearby flooded agricultural fields and wetlands for roosting (Littlefield & Ivey, 2000).

Given their lifecycle and habitat needs, the greater sandhill cranes can benefit substantially from changes in land management on agricultural lands. Such changes include reduced disking or plowing of harvested cropland to minimize the amount of waste grain that is buried as a result of tillage practices, targeted field flooding to create suitable roost sites, and increasing the rate of seeding to compensate for the loss due to foraging (Golet, 2011). Increasing the amount of wintering habitat will help to support the greater sandhill crane population.

Analysis has shown that the program has the potential to support an additional 700 individuals (Table 2-5 and TFT, 2017). Site specific results are not presented due to the sensitive nature of restoration and conversation on private lands.

Table 2-5. Potential acreage of wintertime habitat for greater sandhill cranes within the recycled water delivery area and the targeted benefit of the program.

Total Potential Acreage of Crane Habitat	*Proposed Acreage of Habitat Managed for Cranes*	*Estimated Increase in Greater Sandhill Crane Population*
10,500 acres	3,500 acres	700 individuals

Conservation and Restoration of Vernal Pools

Vernal pools are shallow, depressional wetlands fed by precipitation in the winter and spring (Smith & Verrill, 1998). These seasonal wetlands begin filling with water during the winter, but

become dry during the summer. Given the ephemeral nature and wide-ranging conditions, these wetlands create a unique ecosystem that provides habitat for a large number of species, many of which are endemic (Marty, 2005). Vernal pools provide habitat for many different sensitive species, including California tiger salamanders *(Ambystoma californiense)*, vernal pool tadpole shrimp *(Lepidurus packardi)* and vernal pool fairy shrimp *(Branchinecta lynchi)*
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The Program has the unique ability to tie in wide expanses of summer raptor foraging habitat, winter crane habitat, and vernal complexes in a single large, connected region. By integrating vernal pools and channels and their associated upland contributing watershed into the program, the ecological values are maximized and overall management requirements are simplified as the land is managed for these values as a region, instead of small parcels.

The land use within the program area is dominated by agriculture, however, these agricultural land management practices do not preclude the potential for vernal pool conservation or restoration. In fact, recent research has documented that habitat function and species diversity in vernal pools are enhanced by livestock grazing (Marty, 2005). The South County Ag Program provides a unique opportunity to expand initial work with producers to include vernal pool conservation and restoration. Vernal pool conservation would require collaborating with producers to develop a comprehensive, site-specific management plan to address the limiting factors at the site. Large areas with appropriate topography (depressional areas) and soils (poorly drained) will be targeted as part of the program.

The results of spatial analysis indicate that approximately 100 agricultural fields within the delivery area are likely well-suited for vernal pool restoration (Table 2-6). All areas are 5 acres or larger, with a mean field size of approximately 50 acres. This corresponds to a total of approximately 4,600 acres within the delivery area. Site specific results are not presented due to the sensitive nature of restoration and conversation on private lands.

Table 2-6. Potential for vernal pool habitat restoration in the delivery area.

Number of Fields	*Total Area (acres)*	*Mean Field Size (acres)*	*Conservation Target (acres)*
98	*4,615*	*47*	*500*

While implementing active restoration or conservation on all of these potential acres is beyond the scope of this program, targeted projects on a subset of the vernal pool acres is a part of the program proposal. As part of the South County Ag Program, 500 acres of vernal pool habitat will be targeted for restoration and conservation to improve habitat conditions, while remaining consistent with local agricultural practices. In addition to improved vernal pool habitats, securing strategic conservation easements in the program area will help protect these valuable habitats from future conversion to crops within minimal habitat values.

Instream Flow Benefits

An additional benefit of the increased groundwater levels is increased flows in the Cosumnes River. The Cosumnes River experiences reduced instream flows during the fall, limiting the migration of fall-run Chinook salmon (Fleckenstein et al., 2001). In past years, instream flows during the migration period (October to December) have been so low that reaches of the lower Cosumnes River have been dry for much of migration window (Fleckenstein et al., 2004). These conditions have limited fish passage and impacted fall-run Chinook.

A direct benefit of the program will be the improved instream flows in the Cosumnes River. In particular, the expected instream improvements will be greatest under low-flow conditions (RMC, 2017).

The magnitude of the instream improvement as a result of the program is evident at higher base flow. Under the 2030 conditions, Cosumnes River flows are expected to exceed 10 cfs 64% under baseline conditions, and 80% of the time with the program in place (RMC, 2017). These improved base flows will not only benefit the returning Chinook salmon, but will also provide habitat for the native resident fish and aquatic organisms in the Cosumnes River, including Pacific lamprey (*Lampetra tridentata*), Prickly sculpin (*Cottus asper*), and riffle sculpin (*Cottus gulosus*).

Without the program in place, the instream conditions within the Cosumnes River will continue to degrade under both climate change scenarios, effectively eliminating the flow and habitat necessary to support these resident fish. Benefits for these resident fish are also expected under the 2070 climate change scenario. Under the 2070 scenario, baseline flows would exceed 10 cfs 56% of the time, but with the program in place, flows would exceed 10 cfs 64% of the time (RMC, 2017).

Instream benefits can also be articulated as a total flow volume improvement to the river (acre-feet/year). Across all 84 modeling years, the improve flows in the Cosumnes River can be converted into a mean total water volume increase of approximately 15,500 acre-feet/year under the 2030 climate change scenario.

In addition to the magnitude of the improved instream flow conditions, the timing of those improvements is relevant to supporting fall-run Chinook in the Cosumnes River. During the migration period (October to December), fish passage through the lower Cosumnes River is limited by the reduced instream flows. To support passage through the system, Fleckenstein et al. (2004) identified a minimum discharge of 20 cfs (0.57 m^3/s) during the migration window for the Cosumnes River.

The base flow improvements of the program will also benefit fall-run Chinook in the Cosumnes River by supporting a longer time period during the migration window where flow exceed the minimum flow needed for passage. Under the baseline conditions, only 42% of the migration window meets or exceeds the minimum flow for the 2030 climate change scenario and only 20% under the 2070 scenario. With the Program, the number of days that meet or exceed a flow target of 20 cfs increases to 56% of the migration window for the 2030 climate change and 35% under 2070 climate conditions.

Historically, the Cosumnes River has supported a larger population of fall-run Chinook salmon than what is observed today. Restoration goals for fall-run Chinook in the Cosumnes River include a mean annual spawning run population of 2,000 adults, with a 10-year mean ranging from 1,000 to 5,000 adults (Kleinschmidt Associates, 2008). Past observations of returning fall-run Chinook ranges from 0 to 1,350 adults, with a mean of 418 (California Department of Fish and Wildlife, 2017; Figure 2-2).

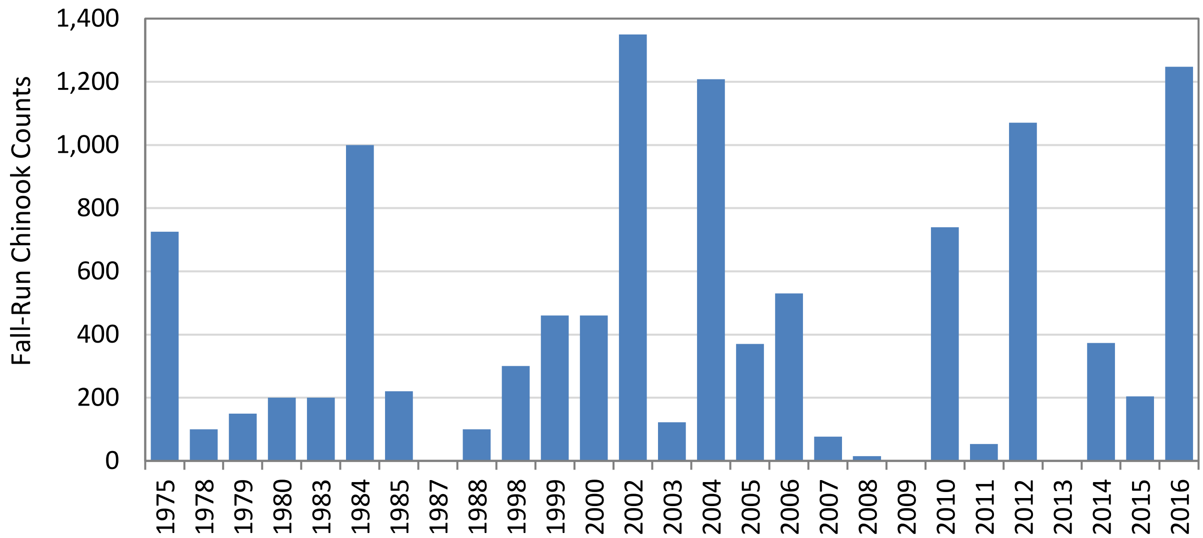

Figure 2-2. Cosumnes River fall-run Chinook population estimates. No population data were available for years that are not included on the graph (1976, 1977, 1981, 1982, 1986, 1989-1997, and 2001). Population data from California Department of Fish and Wildlife (2017).

While the exact benefit of the improved Cosumnes River flows to fall-run Chinook populations is not known, the expected population improvements can be estimated based on the larger migration window. As mentioned above, the mean length of the migration window will increase by 34% with the program in place under the 2030 climate change scenario.[5] Assuming that the increase in the length of the migration window will support a proportionally larger population of fall-run Chinook, this 34% increase was applied to the mean fish population of 418 to estimate the expected increase (Table 2-7). The same assumption was applied to the increased migration window under the 2070 climate change scenario (Table 2-7).

[5] The data used to populate Table 2-7 are based on the results from the full set of simulations, including the initial ramp-up period at the beginning of the project. As such, the values reflect both the expected annual variation in flow as a result of the cycle of hydrologic years, and the fact that the full instream flow benefits of the project will not be immediately realized.

Table 2-7. Estimated increase in adult fall-run Chinook populations as a result of the improved base flows from the program during the migration window (October to December). Increases in populations are based on the percent increase in the length of the migration window and the observed annual mean population of 418 adults (Figure 2-2).

Scenario	*Increase in Migration Window (Days, % Increase)*	*Estimated Increased fall-run Chinook Population (Number of Adults)*
2030 Climate Change	*13.1 (34%)*	*143*
2070 Climate Change	*6.0 (23%)*	*95*

Herbaceous wetland improvements

The final ecosystem benefit analyzed for the program involves a combination of the management tools described above: targeted, site-specific winter water application and invasive weed management. Managed and unmanaged wetland areas exist within and surrounding the currently delineated water delivery area for which for the modeled groundwater benefits are minimal; therefore, these wetland areas are not included in the benefits described in previously. However, delivery of water to these existing wetlands can mitigate the risk of reduced function resulting from disconnection of wetland plants and soils from the groundwater table. Winter flooding, as discussed above for the support of sandhill crane habitat, can maintain shallow groundwater conditions to support wetland soils and vegetation, allowing for the continued provisioning of important ecosystem services by these wetland areas (e.g., listed species habitat and nutrient cycling). Additionally, controlling the presence and spread of invasive species within wetlands receiving water from the program will further increase wetland health and resulting function. This type of wetland conservation and restoration would require collaborating with landowners to develop a comprehensive, site-specific management plan to address the limiting factors at the site. Large areas with appropriate topography (depressional areas) and soils (poorly drained) will be targeted as part of the program.

Approximately 1500 acres of potential wetlands for water delivery to managed lands (by TNC or other agencies) haven been identified (TFT, 2017). An additional 1000 acres of potential wetlands for water delivery to unmanaged lands have also been identified (TFT, 2017). Using a tracking and transaction program, landowners with suitable acreage that can be reliably maintained in suitable condition, would be targeted for long-term agreements, and adjacent properties with similar values would be secured using shorter-term agreements. The willingness of landowners to participate, as well as the existence of appropriate conditions of this type of management, is expected to differ between managed and unmanaged lands, with more willingness and feasibility anticipated on currently managed wetlands. Therefore, project targets have been set for participation at 1,000 acres of the 1,500 managed wetland acres (approximately two-thirds) and 300 of the 1,000 unmanaged wetland acres (approximately one-third).

Summary of Ecosystem Benefits

As mentioned above, there are four primary ecosystem benefits expected from the program: (1) direct improvement as a result of the water application and delivery, (2) direct improvements that require active management to achieve the ecosystem benefit (e.g., weed treatment), (3) habitat restoration that requires active management or implementation, and (4) complimentary changes in land management to support wildlife. These benefits will accrue at different rates depending on the timeline of groundwater improvements or anticipated management action implementation. Table 2-8 (which spans two pages) summarizes the benefits discussed above and the corresponding units of uplift used for monetization.

Additional detailed groundwater modeling during the project planning phase will allow the type of strategic application of water to improve flows in the Cosumnes River, improve wetlands both by increasing groundwater levels and by applying water to areas that will not experience groundwater levels high enough to be supportive, and provide increased sandhill crane and vernal pool habitat. The Ecological Plan describes a combination of land acquisition, management, and delivery strategies that result in a matrix of habitat types, including both on working agricultural lands and preservation areas, to support a variety of wildlife species and ensure continued ecosystem services provisioning in this region. The ecological improvement resulting from the program are distributed across the landscape, increasing habitat connectivity longitudinally along the Cosumnes River, as well as between the Cosumnes River and Snodgrass Slough.

Table 2-8. Summary of the ecosystem benefits from the South County Ag Program under the 2030 and 2070 climate change scenarios (continued on following page).

Ecosystem Benefit	Current Land Use	2030 Climate Change Scenario	2070 Climate Change Scenario	Site-specific Water Application	Weed Management	Unit for Monetization
Direct Program Benefits from Groundwater Improvements						
Increased migration window in Cosumnes River for fall-run Chinook	N/A (instream benefit)	143 adults	95 adults			Additional adult salmon supported
Increased flow volume in the Cosumnes River (acre-feet/year)		15,511 AFY (annual mean)	11,987 AFY (annual mean)			Increased flow volume
Improved groundwater conditions to support existing wetland vegetation (10ft of surface 80% of time; acres)	Managed wetlands	361 ac	1,198 ac			Acres with 5% functional improvement
Improved groundwater conditions to support establishment of wetland vegetation (5ft of surface 80% of time; acres)		811 ac	54 ac			Acres with 10% functional improvement
Improved groundwater conditions to support existing wetland vegetation (10ft of surface 80% of time; acres)	Unmanaged wetlands	1,291 ac	1,109 ac			Acres with 25% functional improvement
Improved groundwater conditions to support the establishment of wetland vegetation (5ft of surface 80% of time; acres)		670 ac	144 ac			Acres with 50% functional improvement

Table 2-8 (continued). Summary of the ecosystem benefits from the South County Ag Program under the 2030 and 2070 climate change scenarios.

Ecosystem Benefit	Current Land Use	2030 Climate Change Scenario	2070 Climate Change Scenario	Site-specific Water Application	Weed Management	Unit for Monetization
Program Benefits from Management & Restoration						
Habitat management for wildlife (Greater sandhill cranes; acres)	Agricultural fields (row crops)	3,500 ac (project target)	3,500 ac (project target)	X		Increase acres of habitat or # cranes supported
Vernal pool restoration/ re-establishment (acres)	Agricultural fields (with potential for vernal pools)	500 ac (project target)	500 ac (project target)	X	X	Increased acres of habitat
Groundwater-supported wetland & riparian forest restoration (acres)	Wetland forests	500 acres (10 miles) (project target)	500 acres (10 miles) (project target)		X	Acres with 95% function
Water delivery-supported wetland restoration (acres)	Managed wetlands	1,000 ac (project target)	1,000 ac (project target)	X	X	Acres with 10% functional improvement
	Unmanaged wetlands	300 ac (project target)	300 ac (project target)	X	X	Acres with 50% functional improvement

2.0.2 Non-Public Benefits

Operations of the Program will also support the following non-public benefits:

- Water Supply Reliability
- Avoided Fertilizer Costs
- Avoided Discharge Costs

Water supply reliability benefits will be received by the recycled water supply users (agricultural users) and potential groundwater banking partners. The supply reliability for farmers is assumed to be of equivalent value to the agricultural users as the existing groundwater supplies, for the purposes of monetizing benefits. However, under the no project scenario, it is likely that the value of a reliable water supply would increase as groundwater availability becomes more scarce (through use, climate change, and/or restrictions for SGMA compliance). Similarly, groundwater banking partners would benefit from reliable water supplies. Under drier conditions, expected in three out of ten years, banked groundwater would be available for pumping and use. The amount of water available would be based on the amount banked in the preceding years and how recharged water is accounted for. See Section 3 of this plan for additional details on banked water extractions.

The Program also provides benefits by avoiding existing costs. For agricultural users, these avoided existing costs are in the form of fertilizer use. The recycled water delivered in-lieu of groundwater pumping would have higher nitrogen concentrations and would allow for a commensurate reduction in nitrogen-based fertilizer application to crops. For Regional San, avoided existing costs consist of pumping costs of to discharge the 50,000 AF each year that the Program would divert from discharge.

2.1 Resiliency

The proposed recharge program is unique in that it has essentially constant water available because the tertiary treated water is being produced every day, each year. That continuous supply creates resiliency because it does not require complex predictions of precipitation patterns and flood control requirements, require costly transfers, or be subject to competing environmental demands.

Recharge water is unlikely to decrease since the region's population is stable, and there is significant land area available for additional growth. Stable or increasing populations mean that, because of effective conjunctive use management and with the Sustainable Groundwater Management Act planning, and evolving agricultural water use efficiency, there is likely to be more water available for recharge and less demand in the recharge area than the estimations made for this program.

2.1.1 Operational Drought Resiliency

The only periods that recharge water is not being provided are under limited scenarios with multi-year droughts. The modeled program benefits under a conservative approach, even with three out of ten years of limited in-lieu recharge, demonstrated that the project groundwater benefits would continue. The groundwater analysis and modeling already include a drought resiliency scenario to ensure that the project benefits would continue to accrue. This operational flexibility means that a variety of groundwater management programs could function even under sustained droughts to still achieve the project benefits.

However, the modeled scenarios do not reflect operational flexibility that can be gained at the local scale. The program has the ability to strategically provide water at specific locations throughout the delivery area to ensure that the benefits will be provided at the correct locations to optimize the ecological benefits regardless of local variations in groundwater hydrology and drought conditions. Targeted deliveries are particularly amenable to wintertime recharge.

2.1.2 Ecological Resiliency

The program provides considerable resiliency benefits today and in the future: 1. Reversing the groundwater-stream gradient from losing to gaining, stabilizing and improving the ecological resilience under today's climate. 2. Most starkly, absent the program, baseline conditions in 2030 and 2070 show that the groundwater conditions would not support any of the existing public conservation lands in the area.

Stated another way, the groundwater improvements and surface water benefits from this project provide the resiliency from modeled climate change impacts to support and protect existing private and public investments in the watershed. This protection of existing investments is in addition to the proposed program benefits.

The benefits of the South County Ag Program will extend far beyond the values presented above. The program combines improved water management with changes in land management for wildlife and habitat restoration, creating a holistic program that addresses a multitude of limiting factors. Combined, these benefits will not only enhance conditions within the region, but will improve the region's resiliency to the impacts of climate change. Enhancing ecosystem resiliency will allow these systems to withstand increased disturbances before changing state, as well as improving their ability to recover from natural disturbances.

One important aspect of the modeling effort is the inclusion of not only the anticipated changes in climate, but also the anticipated periodic drought cycle for the region. Some groundwater extraction is anticipated under these drought conditions and are included in the groundwater modeling performed to date. Incorporating these varying conditions into the modeling provides an opportunity to evaluate potential ecosystem impacts from these dynamic conditions. The modeling results demonstrate not only the persistence of ecosystem benefits generated by the program, but also the magnitude of ecosystem improvements. Even with variable hydrologic conditions and the anticipated impacts of climate change, the program will have substantial, and persistent, ecosystem benefits to the program area.

As the modeling results demonstrate, projects like the South County Ag Program are more important than ever to buffer against, or even reverse, the negative effects of climate change. Without the program in place, instream flows in the Cosumnes River will continue to decline, leaving the river with effectively no flow for 25% of the year (TFT, 2017 and RMC, 2017). The groundwater declines that are anticipated under the climate change scenarios will continue to degrade riparian and wetland ecosystems without the program in place; not only harming existing high-quality habitat, but limiting the potential for restoration opportunities as it will become increasingly difficult to establish and sustain these ecosystems.

One important benefit of the South County Ag Program will be the improved ecosystem resiliency for the entire area, including the area currently managed for conservation. The results of the climate change modeling highlight the extensive negative impact that these changes will have on the currently high-quality ecosystem communities in the program area. Over the past few decades, many millions of both public and private dollars have been invested in the region to improve ecological conditions. This work has resulted in significant ecosystem improvements that are at risk of degrading, or being lost altogether, in the face of climate change. Under the baseline conditions, the continued decline in groundwater levels will occur under both climate change scenarios, resulting in fewer acres capable of sustaining riparian or wetland vegetation. Without the program in place, the declining groundwater elevations will severely impact the ecological function of these conserved and restored habitats. As such, an additional benefit of the program will be the continued support of these managed ecosystems, protecting the extensive resources that have been invested in the region against the impacts of climate change.

2.2 Wet Years Recycled Water Deliveries Operations

Recycled water deliveries are not expected to change in wet year scenarios. Timing of wintertime irrigation recharge may be impacted by wet conditions, but would not impact operations on a seasonal or monthly level. After the groundwater basin reaches equilibrium, the benefits of recycled water recharge may be slightly reduced in magnitude in wet years based on availability of surface water flows and natural recharge. This reduction in benefits value is not due to operational conditions but because the recycled water deliveries are more valuable or beneficial in drier conditions, when alternative water sources are more scarce. Operationally, recycled water deliveries would continue as described in the previous section as long as conditions allow for recharge up to 49,500 AFY (44,500 AFY through irrigation, 5,000 AFY through recharge areas).

Table 2-9. ***Summary of recycled water delivery operations in wet years***

Deliveries	Amounts	Limiting Factors
Irrigating Season (May – Sept)		
Irrigated Area	Up to 37,000 AFY (avg 32,500 AFY)	N/A
Recharge Area	5,000 AFY	N/A
Refuge	Up to 500 AFY	N/A
Wintertime (Oct – April)		
Irrigated Area	Increasing annual deliveries to 44,500 AFY	N/A
Recharge Area	5,000 AFY	N/A
Refuge	Up to 500 AFY	N/A

2.3 Dry Years RW Deliveries Operations

Recycled water deliveries are not expected to change in most dry year scenarios. Recycled water deliveries may become more impactful in dry years for agricultural irrigation, groundwater recharge, and refuge supplies as there is generally greater need for alternative water supplies under dry conditions. Under conditions that would necessitate implementation of Mitigation Measure HYD-4 of the Program Environmental Impact Report (EIR)[6], irrigation deliveries during the irrigating season may be reduced by up to 50 percent under full buildout conditions.

[6] HYD-4- In critically dry years when storage in Lake Shasta falls below 2,400,000 AF in April, Regional San will coordinate with Central Valley Operations staff to reduce deliveries of recycled water to farmers in April and May if needed to avoid thermal impacts to the Sacramento River below Lake Shasta, as determined by the Sacramento River Temperature Model being utilized by Reclamation in the given year. https://www.regionalsan.com/sites/main/files/file-attachments/draft_eir_final.pdf, pg 3.5-54.

Before buildout, maximum discharge reductions would be proportionately less[7]. Wintertime deliveries following those reduced seasons would be increased to maintain overall annual deliveries of 50,000 AF under full project buildout conditions. Changes to recycled water deliveries due to compliance with HYD-4 are not expected to significantly impact Program operations. Modeling for 2030 climate change conditions shows only two out of the 84-year modeling simulation would HYD-4 be triggered, and for 2070 modeling only eight out of 84 years modeling would HYD-4 be triggered. Modeling under 2070 with climate change conditions reveals that the expected average Irrigation Season deliveries would decrease from approximately 32,500 AFY to 31,000 AFY[8]. The difference of 1,500 AFY would be made up in the Wintertime season or other times when HYD-4 is not in effect within the affected water year.

Over the 42-year hydrology (1970-2011), HYD-4 triggering conditions occur in one year with the 2030 Climate Baseline and in four years with the 2070 Climate Baseline. Since the SacIWRM simulates the 42-year hydrology twice, over the entire 84-year of simulation period, this occurs in two years with the 2030 Climate Baseline and in eight years with the 2070 Climate Baseline.[9]

Table 2-10. ***Summary of recycled water delivery operations in dry years***

Deliveries	Amounts	Limiting Factors
Irrigating Season (May – Sept)		
Irrigated Area	Up to 37,000 AFY (avg 32,500 AFY)	Potential cuts to irrigation deliveries to increase discharges to Sacramento River, per EIR Mitigation Measure HYD-4
Recharge Area	5,000 AFY	Same as for irrigated area
Refuge	Up to 500 AFY	N/A
Wintertime (Oct – April)		
Irrigated Area	Increasing annual deliveries to 44,500 AFY	Potential increases over wet or normal years to compensate for cuts in deliveries during the Irrigation Season
Recharge Area	5,000 AFY	Same as for irrigated area
Refuge	Up to 500 AFY	N/A

[7] Final reductions to be determined in the relevant water year to achieve benefits claimed and modeled in support of the CWC WSIP grant application.
[8] Woodard & Curran, 2017. Technical Memo, South Sacramento County Agriculture and Habitat Lands Recycled Water, Groundwater Storage, and Conjunctive Use Program, Integrated Groundwater and Surface Water Modeling Results Technical Memorandum, Prepared for Regional San, Blanke, J and Onsoy, S., July 6, 2017, pg. 33.
[9] Ibid., pg. 32.

2.4 Multi-year Dry RW Deliveries Operations

Recycled water deliveries under multi-year dry conditions would be the same as for dry conditions. The multi-year dry conditions would increase the likelihood for Mitigation Measure HYD-4 to be triggered, (two out 84 years for 2030 scenario and eight out 84 years for 2070 scenario) but operations would follow those outlined in the Dry Years RW Deliveries Operations section above. Reductions in deliveries during the irrigating season would be compensated by increased deliveries in the wintertime or times when HYD-4 is otherwise not in effect.

3. Groundwater Bank Extraction Operations

Because recycled water would be used to meet most of the irrigation demand in place of groundwater, the proposed Program would provide in-lieu recharge. Additionally, wintertime irrigation and use of recharge areas would add an additional recharge component. The fully implemented Program would also include an administrative accounting framework such that the water savings over the life of the proposed Program would be accrued and reserved (groundwater banking) for other uses in the future, including maintaining a sustainable groundwater baseline or threshold, as outlined below.

As groundwater conditions improve and exceed minimum groundwater level and quality thresholds (to be finalized with coordination with the Sacramento Central Groundwater Authority through the Sustainable Groundwater Management Act (SGMA) process), groundwater extraction would occur on an as-needed basis for a variety of regional water supply and reliability needs, including instream flow needs for fish, ecosystem viability, agricultural irrigation, municipal and industrial (M&I) uses, and other regional and Delta needs. Preliminary modeling suggests that the Program could increase groundwater storage in the basin by approximately 320,000 to 590,000 acre-feet (with Program as compared to without Program, between approximately 25 years under 2030 climate conditions to 80 years under 2070 climate conditions, respectively)[10]. The volume actually stored will vary with banking operations on an annual basis, but preliminary plans are to withdraw in the driest three out of ten years, and approximately 30,000 AFY will be withdrawn in those years, leaving approximately 70 percent of the banked water in the basin. Groundwater extractions would be closely monitored to maintain the target groundwater levels in habitat areas.

Groundwater bank extractions are not expected to occur in wet or normal water years. Groundwater bank extractions would occur under dry and multi-year dry conditions, provided that the groundwater bank accounting demonstrates water available for extraction, and that minimum historic groundwater levels and claimed environmental benefits are maintained.

[10] Ibid., pgs. 81 and 84.

3.0 Planned Extraction of Stored Water

Extraction scenarios were modeled using the Future Conditions Baseline SacIWRM. The 42-year hydrologic conditions of 1970-2011 were repeated two times to evaluate the long-term effects of water resources activities on the basin. The modeling analysis followed the WSIP guidelines and used two future climate change conditions that were developed to represent the 2030 and 2070 climate change conditions. Hydrologic data (precipitation, evapotranspiration, and streamflow) were modified to represent the 2030 and 2070 climate change conditions in the Program area.

Approximately 70 percent of recharged water is assumed to be unavailable for extraction, as it is intended to benefit ecosystems, groundwater users, partially or fully mitigate outflow from the basin, and contribute to overall basin sustainability. The remaining 30 percent of recharged water is available for extraction, which occurs during the driest 30 percent of years and recovers an average amount of banked water equivalent to the annual average in-lieu recharged volume. Modeling results for extraction availability and effects under 2030 and 2070 climate change conditions are shown in figures 3-1 and 3-2 below.

For modeling purposes, during identified dry periods, it is hypothetically assumed that the City of Sacramento and the Sacramento County Water Agency (SCWA), or their respective wholesale customers, would limit their surface water deliveries and shift to groundwater pumping of the banked water. Regional San is having ongoing discussions of the proposed project banking and recharge operations with the Sacramento Central Groundwater Authority, which includes a broad consortium of these agencies, including the City of Sacramento and Sacramento County. Although no final agreements have been reached with these agencies, the proposed project banking and recharge operations are consistent with the conjunctive use plans of these agencies. The proposed project extractions will be further refined in coordination with the Sacramento Central Groundwater Authority and its member agencies as a water accounting framework and groundwater bank is developed, along with additional environmental analysis. This recovery could allow for the sale of the surface water to other entities and/or improved reliability. It is assumed that approximately 30,000 AFY would be available for extraction in the driest 30 percent of years based on recovery at the rate of recharge, when banked water is available. The extraction is ceased when the "banked" water reaches zero to avoid extracting more than 30 percent of recharged water.

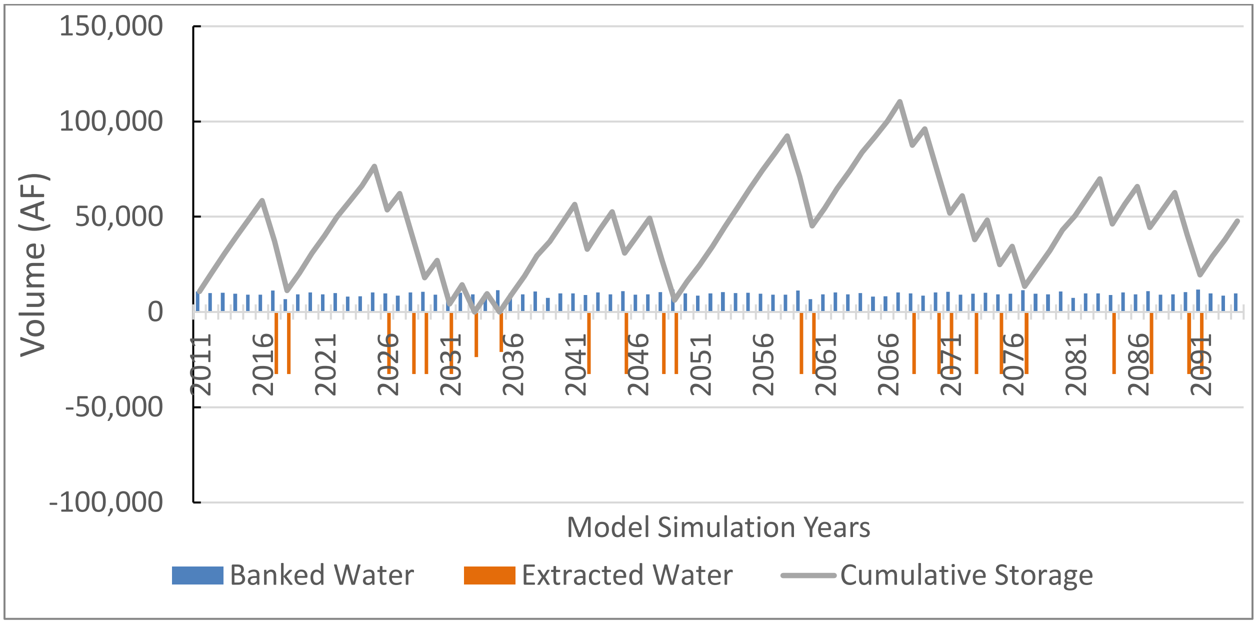

Figure 3-1. Program Scenario with 2030 Climate Change - Accounting of Banking and Extraction, and Cumulative Stored Water

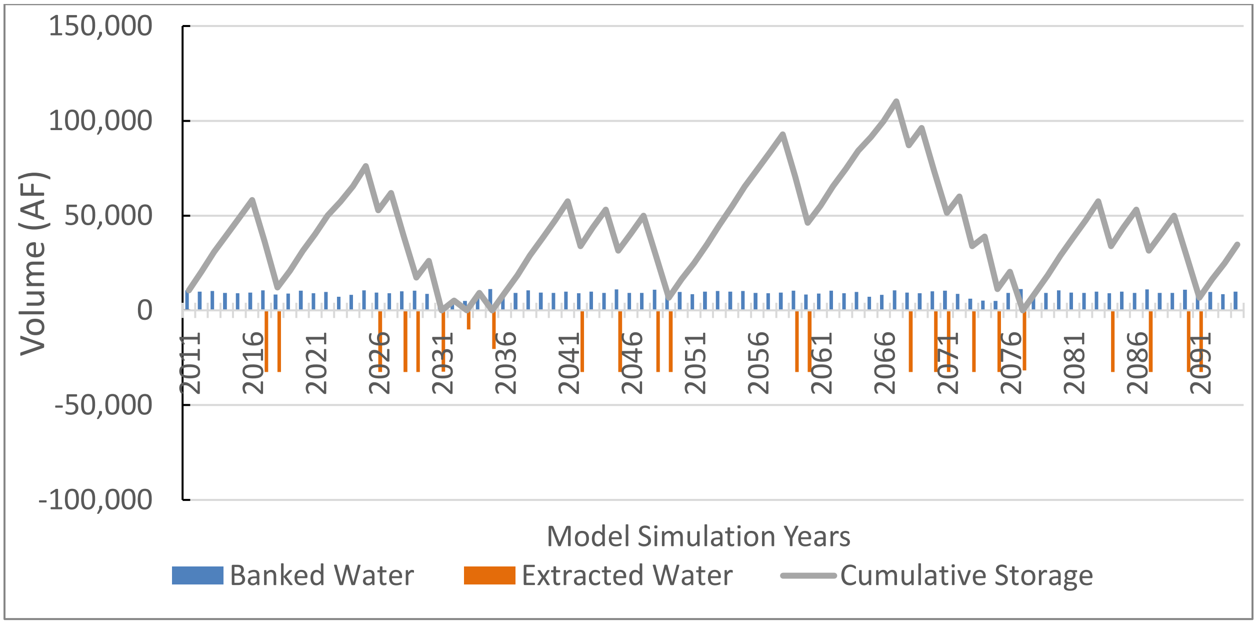

Figure 3-2. Program Scenario with 2070 Climate Change - Accounting of Banking and Extraction, and Cumulative Stored Water

3.0.1 Commitments for Providing Operations or Water Supply for Public Benefits

Regional San is committed to building the Program to provide environmental benefits. The approximately 70 percent leave behind of recharged groundwater, and developing a groundwater bank, reinforces this commitment. Regional San consulted with The Nature Conservancy early in the Program development process to identify potential Program benefits and needs, and how to maintain environmental benefits while providing other benefits to regional water users. The Nature Conservancy continues to be involved in Program implementation through preliminary modeling, recharge area planning, wintertime irrigation research, and Program monitoring after implementation.

The 30 percent of recharged groundwater that would be available for other uses, including additional environmental benefits, represents the groundwater available in the bank. It is currently assumed that extraction of banked groundwater can be used conjunctively to offset a commensurate amount of surface water diversions along the American and/or Sacramento Rivers. Regional San is in the early processes of developing a groundwater accounting framework and program.

3.0.2 Emergencies Services Reliability

The proposed Program does not currently include flood reservation space or other dedicated storage space. However, Program infrastructure can also be used to support emergency fire response in the Program area. As part of the Program, the delivery pipeline that will be constructed to deliver water to agricultural producers can also be utilized by rural fire departments. The addition of standpipes along the delivery pipeline that meet the specifications for emergency fire response would create a supplemental source of water in the area, improving the reliability of water availability and emergency response.

3.1 Storage Rules

As described above, 70 percent of the groundwater recharged would be left in the basin to provide multiple public benefits. Groundwater banking extractions would only be for the remaining 30 percent of groundwater recharged. Extractions would recover an average amount of banked water equivalent to the annual average in-lieu recharged volume. Groundwater bank extractions would not occur if groundwater bank accounting demonstrated that no water from the 30 percent recharged is available, minimum historic groundwater levels are not being met, or claimed environmental benefits were not being maintained.

SGMA requires Groundwater Sustainability Agencies (GSA) to be formed in medium and high priority basins to create and implement Groundwater Sustainability Plans (GSP) for achieving sustainable groundwater management in each high or medium basin or subbasin in the state. GSA formation is currently underway in the subbasin. Multiple GSA formation notices have been submitted for the subbasin, including SCGA. Refinement and finalization of GSA boundaries and coordination is on-going. Regional San will work with the relevant agency or agencies to operate the Program in a manner to help facilitate the goals and implementation of SGMA and groundwater banking operations rules yet to be negotiated.

SCGA is the GSA for where the Program is located. Regional San is represented on SCGA's Board, and is integral to helping establish a Groundwater Accounting Program that will lay a foundation for groundwater banking. The Program will also help contribute to the resiliency of the groundwater basin, as currently reflected in the Alternative Plan SCGA submitted to DWR in December 2016, and will support any future Groundwater Sustainability Plan developed for the Basin.

4. Maintenance and Monitoring

4.0 Maintenance

Maintenance of the Program would primarily involve regular inspections of the pipelines, pump station(s), and banking extraction wells. The pipelines would be inspected as needed in any given year, and the pump station would be inspected monthly. Existing Regional San operations and maintenance staff would conduct maintenance activities. Extraction wells are already in place for the City of Sacramento and SCWA, and would continue to be maintained by those respective agencies.

4.1 Monitoring

As part of ongoing operations, monitoring would be conducted to quantify benefits to the groundwater basin and to document the assurances that Regional San is providing to stakeholders and funding agencies as the Program is developed. Monitoring would be done in cooperation with The Nature Conservancy and other resource managers responsible for lands within the Program. Groundwater banking operations would be coordinated with the sustainable groundwater plan or equivalent, when finalized. Regional San anticipates development of a monitoring and reporting plan that would include groundwater elevations, to be developed in coordination with existing and planned groundwater monitoring.

4.1.1 Riparian Corridor Health

Riparian corridor health would be monitored through groundwater elevation measurements and riparian vegetation surveys. A monitoring program will be developed by Regional San with input from The Nature Conservancy and other stakeholders to quantify the Program's environmental benefits. Additionally, should the Program receive Conditional Approval, a contract with the California Department of Fish and Wildlife Services will be created that documents monitoring requirements to demonstrate performance. A groundwater elevation monitoring network would be established in the Cosumnes River Corridor between Interstate 5 and Highway 99 to the West and East, and Bilby/Kammerer Road to the North and Twin Cities Road to the South. Existing wells would be used to the extent possible. Numerous agricultural wells exist in and near the Program area, and the effort would seek to include wells monitored by UC Davis for the

Cosumnes Research Group and by SCGA for the California Statewide Groundwater Elevation Monitoring program. Emphasis would be placed on shallow wells capable of monitoring conditions important to riparian forests. Wells would be focused within the Cosumnes River corridor and specifically near critical areas such as Castello Forest, Valensin Forest, Shaw Forest, Orr Forest, and Tall Forest. If appropriate wells are not present to gain the needed data, new dedicated monitoring wells would be installed.

4.1.2 Ecological Program Monitoring

It is essential to monitor the progress of the program towards achieving the desired future ecological conditions. To confirm that the program remains on a trajectory toward success, monitoring can follow a three-tiered approach, including:

(1) rapid qualitative monitoring at individual sites,
(2) remote effectiveness monitoring of the program area, and
(3) quantitative confidence monitoring on a sample of sites.

These complementary approaches can be used to meet different monitoring objectives, and when combined will provide the necessary assurances that the anticipated ecological benefits are on track to be produced.

Program monitoring will include three main components:

(1) an assessment of the land management practices (wintertime field flooding, crop residue management, etc.) that are in place to create habitat and support wildlife,
(2) riparian and wetland vegetation surveys to evaluate site conditions and function, and
(3) monitoring to assess biological response.

In the case of the first component, annual monitoring of land management practices will ensure that the appropriate practices are being implemented. Information about practices can be gained from surveys of agricultural fields. The specific metrics included in each survey will be dependent on the land management practices that is being monitored, however, such surveys are largely qualitative. The results of the field surveys can information future actions, as well as provide information to inform the adaptive management of the program. Additionally, the field surveys can be used to determine whether site-level corrective actions are necessary to achieve the desired habitat goals.

Vegetation monitoring is an essential component of the long-term program monitoring. Riparian and wetland areas are naturally dynamic ecosystems, as such, it is important to monitor conditions over time to ensure that the ecological functions continue to be supported. A key component of ecological function is driven by vegetation conditions. For example, the proliferation of noxious weeds can severely impact the function at a site. Vegetation monitoring should include all three of the monitoring tiers mentioned above to characterize site conditions and change over time. The frequency of monitoring will be driven by the successional stage of the site and the expected level of variability in site conditions.

One of the primary objectives of the ecological enhancement, restoration, and creation is to improve conditions for aquatic and terrestrial species. Assessing the functions, as described previously, provides insight into the aspects of the program that are known to impact these species, but they do not document changes in the abundance and distribution of these organisms. To ensure that the program is supporting these species as intended, the third monitoring component includes surveys to assess biological response. Qualitative surveys can be conducted more frequently to determine the presence or absence of certain species, as well as their distribution. Quantitative monitoring is necessary to determine abundance and migration patterns.

Qualitative Monitoring

The goal of rapid qualitative monitoring is to quickly ensure that all sites remain in place and are continuing to demonstrate progress toward achieving the expected ecological benefits. Qualitative monitoring can be conducted annually on every site from Program implementation through "establishment." Once sites are established, qualitative monitoring can be used to confirm Program trajectory and function over the life of the Program, but the frequency of qualitative monitoring at a Program site would decrease after establishment. In the case of areas that include a change in annual land management (such as changes in agricultural practices during the critical overwintering period for wildlife), no establishment is expected. Rather, program monitoring would include annual qualitative monitoring of the changes in land management practices for the life of the program.

Qualitative monitoring can be completed by project managers, maintenance crews, or field technicians who have been trained to collect basic monitoring data using standardized protocols. This data collection could include repeat annual photo point monitoring at sites and a rapid, standardized project site assessment "checklist" that is meant to both determine that the site's performance and to identify maintenance concerns that need to be addressed at individual sites. The narrative and visually-based questions on the checklist address the same ecological performance objectives assessed in quantitative monitoring.

Remote Effectiveness Monitoring

All implemented project sites can also be monitored periodically via remote sensing (i.e., LiDAR, satellite imagery, etc.). This method of monitoring allows for efficient tracking of sites spread over a broad geographic area and provides a set of digitized images that allows for effective comparison of site conditions from year to year. As on-the-ground qualitative monitoring decreases in frequency after establishment, remote sensing can help confirm that sites continue to endure and progress. As remote monitoring technology becomes more accurate, efficient, and affordable, methodologies can be adapted to support continued improvements in remote monitoring over the life of the Program.

Quantitative Monitoring

In addition to qualitative monitoring and remote sensing, quantitative monitoring should occur on the ground at a geographically relevant sample of Program sites. Quantitative confidence monitoring can be used to meet three goals:

1) generate empirical data about how Program sites are progressing toward performance objectives known to represent ecological function (e.g., percent canopy cover, percent native woody understory cover for riparian sites);
2) serve as an internal quality control check by connecting empirical trends with qualitative monitoring tool questions and options; and
3) improve effectiveness of implementation and maintenance over time based on the empirical evidence analyzed from these Program sites.

4.1.3 Groundwater Basin Health

Groundwater basin health would be monitored through groundwater elevation measurements. A groundwater elevation monitoring network would be established to cover slightly beyond the Program footprint. Numerous agricultural wells exist in the basin, and the effort would seek to include wells monitored by SCGA for the California Statewide Groundwater Elevation Monitoring program. Emphasis would be placed on wells screened at typical agricultural and municipal well depths. Selected wells for monitoring would be spread across the Program area to allow for estimation of stored water and estimation of losses to surface water. Existing wells in the service area of the yet-to-be-finalized groundwater banking program would be leveraged to the extent possible for banking operations monitoring. Approximately 18 groundwater level monitoring wells are anticipated. If appropriate where wells are not present, new dedicated monitoring wells would be installed. Water level measurements would initially occur monthly and be refined as data is evaluated.

Unrelated to the implementation of the South County Ag Program, the Sustainable Groundwater Management Act of 2014 (SGMA) includes monitoring requirements and recommendations that will help provide information about groundwater levels and establish monitoring protocols within the project area. Groundwater Sustainability Plans, or approved alternatives, are required under SGMA to develop a sufficient monitoring network, providing data that demonstrates measured progress toward achieving basin sustainability goals and showing short-term, seasonal, and long-term trends in basin conditions.

The Department of Water Resources has published Best Management Practices (BMPs) related to developing a monitoring network and protocol that will be considered by the Groundwater Sustainability Agencies overlying the South American and Cosumnes Subbasins.

It is anticipated that, through implementation of SGMA, additional monitoring will be performed in or near the project area. Regional San will develop a monitoring and reporting plan in coordination with local entities implementing SGMA to build upon these planned efforts.

4.1.4 Salt and Nutrient Monitoring

Monitoring of salt and nutrients would occur through regular monitoring of the Groundwater Basin Health monitoring wells. At least two wells would be monitored semi-annually for Total Dissolved Solids and Nitrate for the initial five years of project operations, then annually unless data suggests the need for continuing to monitor more frequently.

4.2 Operations at Other Facilities

Regional San is in the process of upgrading the wastewater treatment plant to tertiary treatment with a project known as EchoWater, scheduled for completion by 2023. The EchoWater project is the source of the recycled water for the proposed Program. The proposed Program would direct 49,500 AFY to wintertime and in-lieu groundwater recharge, and an additional 500 AFY to supplement water supplies at Stone Lakes National Wildlife Refuge. The two projects tie into one another directly.

Existing groundwater wells are planned for use as part of the groundwater bank extraction operations.

4.3 Potential Impacts from Climate Change

Preliminary modeling results actually suggest benefits (public and non-public) would increase under 2030 and 2070 climate change conditions[11]. Agricultural irrigation demand would increase under climate change scenarios, thus resulting in increased recycled water deliveries during the irrigation season, when available. However, it would also be more likely that conditions triggering Mitigation Measure HYD-4 would be more frequent as well. Agricultural irrigation deliveries would increase (up to approximately 37,000 AFY) unless HYD-4 conditions prevented deliveries during this time, in which case wintertime recharge would be used to make up the 49,500 AFY delivered for recharge.

Under future climate conditions, the value of having the proposed Program's reliable source of recycled water for basin recharge generally increases. The proposed Program would increase groundwater levels and storage, as previously described. The importance of the Program for sustaining culturally and economically vital agricultural practices, as well as providing numerous ecosystem benefits in the region, particularly along the Cosumnes River corridor, is magnified by the implications of future climate scenarios. Under anticipated climate change conditions, agricultural water demand is expected to increase. Without the proposed Program, groundwater conditions in the CASGEM high priority basin would likely deteriorate and groundwater levels would drop at an increasing rate. However, modeling results under 2070 climate change conditions show that both groundwater levels and in-stream flows would increase with the proposed Program.

Potential impacts of the Program beyond anticipated 2070 climate conditions would likely be restricted to impacts on surface flows in the Sacramento River. Preliminary modeling suggests that as climate change gets more extreme, the magnitude of impacts related to reductions in flows in the Sacramento River are more pronounced. However, the proposed Program offsets many of these potential flow reductions in the river through improvements in flows in the Cosumnes River, a tributary to the Sacramento River, and reducing losses from the Sacramento River to the groundwater basin. The Program's banking operations can also serve to supplement

[11] Ibid., pgs. 43-46.

or offset surface flows in the region during dry years that might have otherwise been met through surface water diversions.

5. Adaptive Management

Long-term maintenance and monitoring of the components of the South Count Ag Program are essential for the program's success and the attainment of the ecosystem improvements. The three-tiered monitoring approach described in Section 4 will allow for programmatic tracking and evaluation of progress toward achieving the ecosystem benefit and programmatic goals. The multi-decadal timeframe of the program necessitates the ability to adapt implementation, maintenance, monitoring, and performance tracking practices to reflect new knowledge and information as it emerges. As technologies, land management, production, and monitoring practices evolve, it is expected that more efficient approaches or better knowledge about sources and methods to achieve program goals will also develop.

Adaptive management of the South County Ag Program will be implemented on a five-year cycle. A five-year review cycle provides a regular opportunity to review available data from the previous years of implementation, maintenance, and monitoring, and to incorporate new technologies and lessons learned through previous implementation and management cycles into the upcoming implementation, as well as monitoring, maintenance, and performance tracking (Figure 5-1). Periodic review also affords transparency and quality control. A review period of five years is recommended to allow enough time to properly evaluate:

1) progress toward overall programmatic goals, as well as
2) the effectiveness of maintenance approaches and monitoring protocols.

Additionally, the five-year cycle aligns with the anticipated time periods for ecosystem benefit accrual, particularly at the beginning of the program. As such, a five-year window provides enough flexibility to appropriately collect and analyze these data, but also ensures that if management changes are necessary, they can be implemented in a timely manner. Periodic review of implementation and performance progress will also allow for course correction with respect to the ongoing implementation milestones and obligations, should any be needed.

Regional San is financially committed to the success of the Program, including support for monitoring and adaptive management to meet planned benefits. Commitments have also been made through the Program EIR to ensure water quality protection and protection of aquatic species through implementation of HYD-4 in the spring time of critically dry years, which is modeled as only occurring in two out of 84 years. Commitments are also made for monitoring of riparian corridor health, groundwater basin health, and salt and nutrient monitoring.

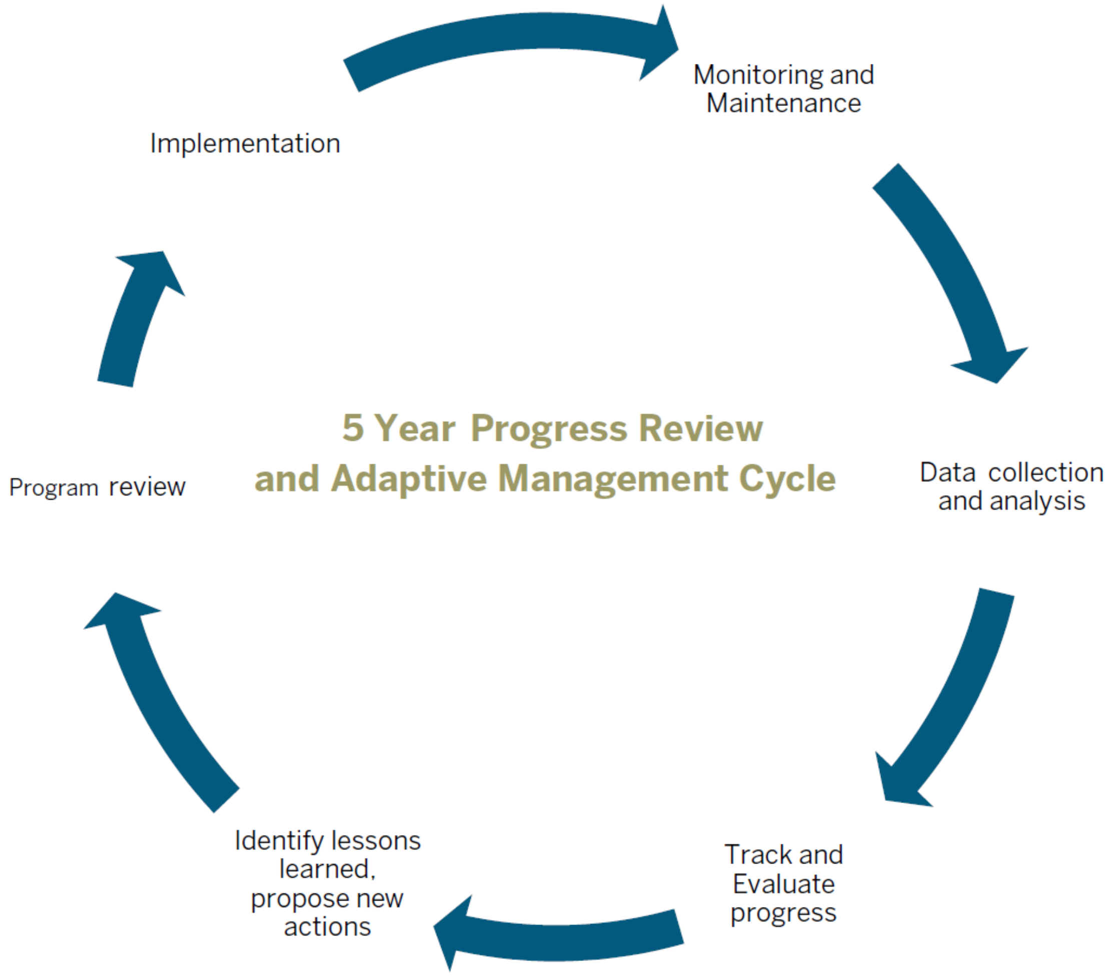

Figure 5-1. Adaptive management cycle for the South Count Ag Program. For each adaptive management cycle the adaptive management approach should include: 1) pre-implementation data collection, which is essential to gauge the impacts of program implementation; and 2) monitoring and maintenance data. Monitoring data will be used to confirm the program benefits and maintenance data will be used to determine what sort of issues are being encountered. Every five years, program implementation, maintenance, and monitoring data should be evaluated and summarized in aggregate. At this time, new restoration actions, recommended changes to implementation or land management approaches, monitoring, and maintenance protocols, etc. may be considered and discussed. The adaptive management cycle should repeat for the next five years of the South County Ag Program.

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